Systematic Multipoles in the Dipoles

and

Their Effect on Dynamic Aperture and A ν-spread

G. Parzen

BNL

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Introduction

Two effects of the systematic multipoles in the dipoles were studied:

1) the effect on the dynamic aperture

2) The ν-spread in the beam at $\gamma = 30$.

The ν-spread in the beam may be the more important effect, as it can be fairly large when compared with the available ν-space of $\Delta \nu = 33 \times 10^{-3}$. The ν-spread appears to be largely due to the systematic b_4. Thus, it can be reduced by about a factor ~~⟨⟩~~ of 2 using the b_4 correction system. It may be desireable to further reduce b_4 below a certain tolerance level given below.

The ν-spread due to random multipoles is also large of the order of $\Delta \nu_{spread} \simeq 17 \times 10^{-3}$. This may be partially correctable. It still may be desireable to reduce the ν-spread due systematic multipoles as much as possible.
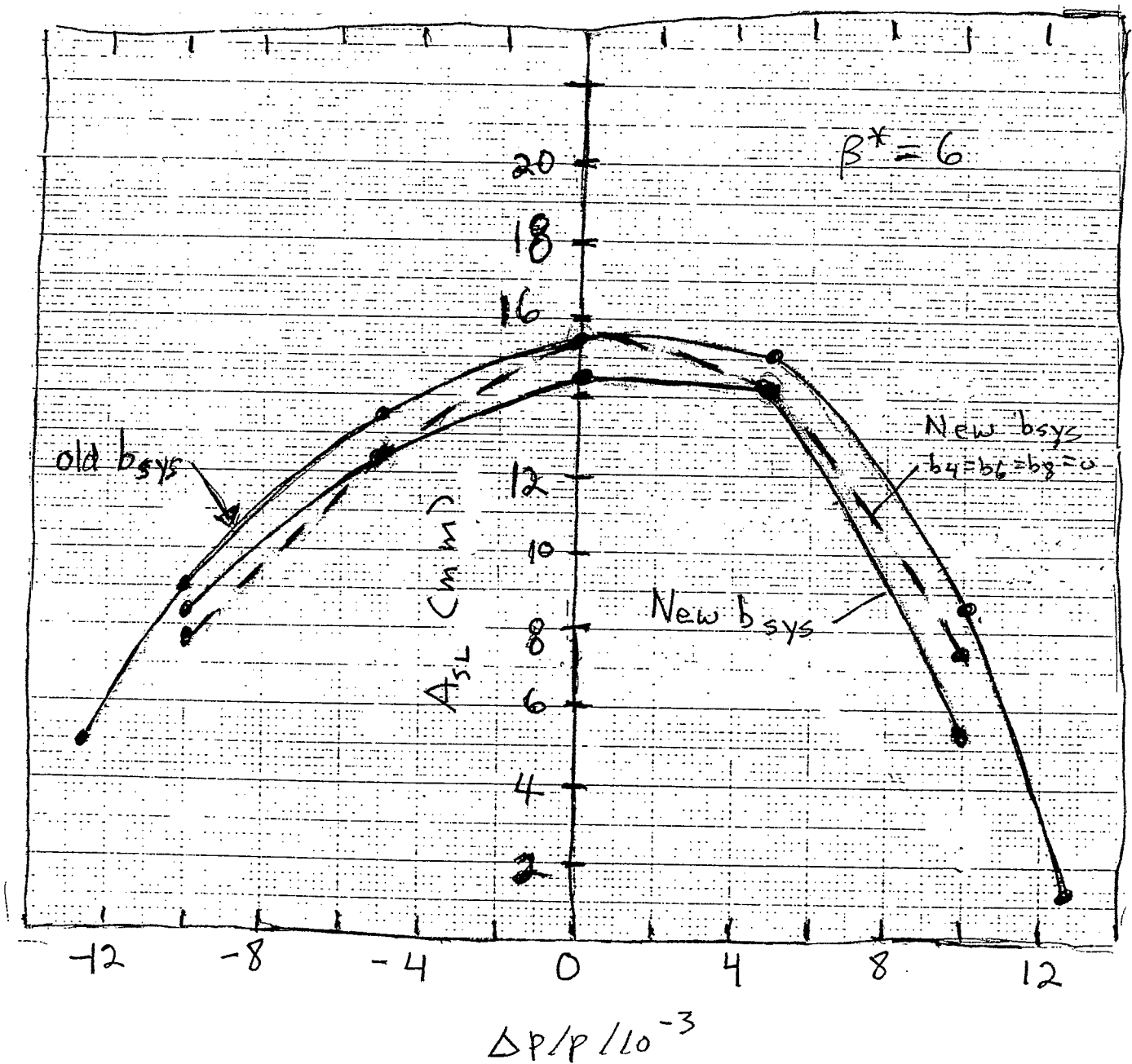
Data for Systematic b'_K

K	old	New 5/89					
2	.02	2.24					
4	.009	.75					
6	.003	.303					
8	.005	.181					
10	.016	-.039					
12	.565	.754					
14	.182	.247					
16	-.19	-.232					
18	.036	.153					

Above data due to Pat Thompson.

This study uses the New data in the third Column

Effect of the Systematic b_K on the Dynamic Aperture

$\beta^* = 6$

old b_{sys}

New b_{sys}
$b_4 = b_6 = b_8 = 0$

New b_{sys}

A_{5L} (mm)

$\Delta p / p / 10^{-3}$

Dynamic Aperture Continued

Effect of Increasing Radius of BC2

Will increasing RBC2 from RBC2=4 cms to RBC2=5 cms still increase A_{SL} with the new $b_{K,SYS}$? The answer is Yes.

With $\underline{RBC2 = 5cm}$, $\delta P/p = 0$

$$A_{SL} = 18.5 \text{ mm}, \text{ -old } b_{K,SYS}$$
$$A_{SL} = 18.5 \text{ mm}, \text{ new } b_{K,SYS}$$

Dynamic Aperture due $b_{K,SYS}$ only (no random b_K, a_K)

$\underline{RBC2 = 4, \delta P/p = 0}$

$$A_{SL} = 16.\underline{5} \text{ mm}, \text{ new } b_{K,SYS}$$
$$A_{SL} = \underline{17}.5 \text{ mm}, \text{ old } b_{K,SYS}$$

$\underline{RBC2 = 5, \delta P/p = 0}$

$$A_{SL} = 19.5 \text{ mm}, \text{ new } b_{K,SYS}$$
$$A_{SL} = 19.5 \text{ mm}, \text{ old } b_{K,SYS}$$

ΔV - spread due to Systematic b_k (no random b_k, d_k)

At $\gamma = 30$, $\sigma_x = 3.1\,mm$, $\Delta P/p = 5 \times 10^{-3}$ after 10 hours

$\mathcal{E}_t = \mathcal{E}_x + \mathcal{E}_y$ for 95% of beam is at
$$X = \sqrt{10}\ \sigma_x \quad (x' = y' = y = 0).$$
$$X = 9.8\,mm, \quad \mathcal{E}_t = 1.92$$

ΔV-spread is found within $\mathcal{E}_t = 1.92$, within 95% beam, and **not** within the $\mathcal{E}_t$ given by 6σ rule, $\mathcal{E}_t = 6.5$.

3 points on $\mathcal{E}_t$ surface were studied

$$\mathcal{E}_x = \mathcal{E}_t, \quad \mathcal{E}_y = 0$$
$$\mathcal{E}_x = \mathcal{E}_t/2, \quad \mathcal{E}_y = \mathcal{E}_t/2$$
$$\mathcal{E}_x = 0, \quad \mathcal{E}_y = \mathcal{E}_t$$

Largest ΔV found for $\mathcal{E}_x = \mathcal{E}_t, \mathcal{E}_y = 0$

$$\Delta V_x, \Delta V_y = -8, 5 \times 10^{-3} \quad \Delta P/p = -.005$$
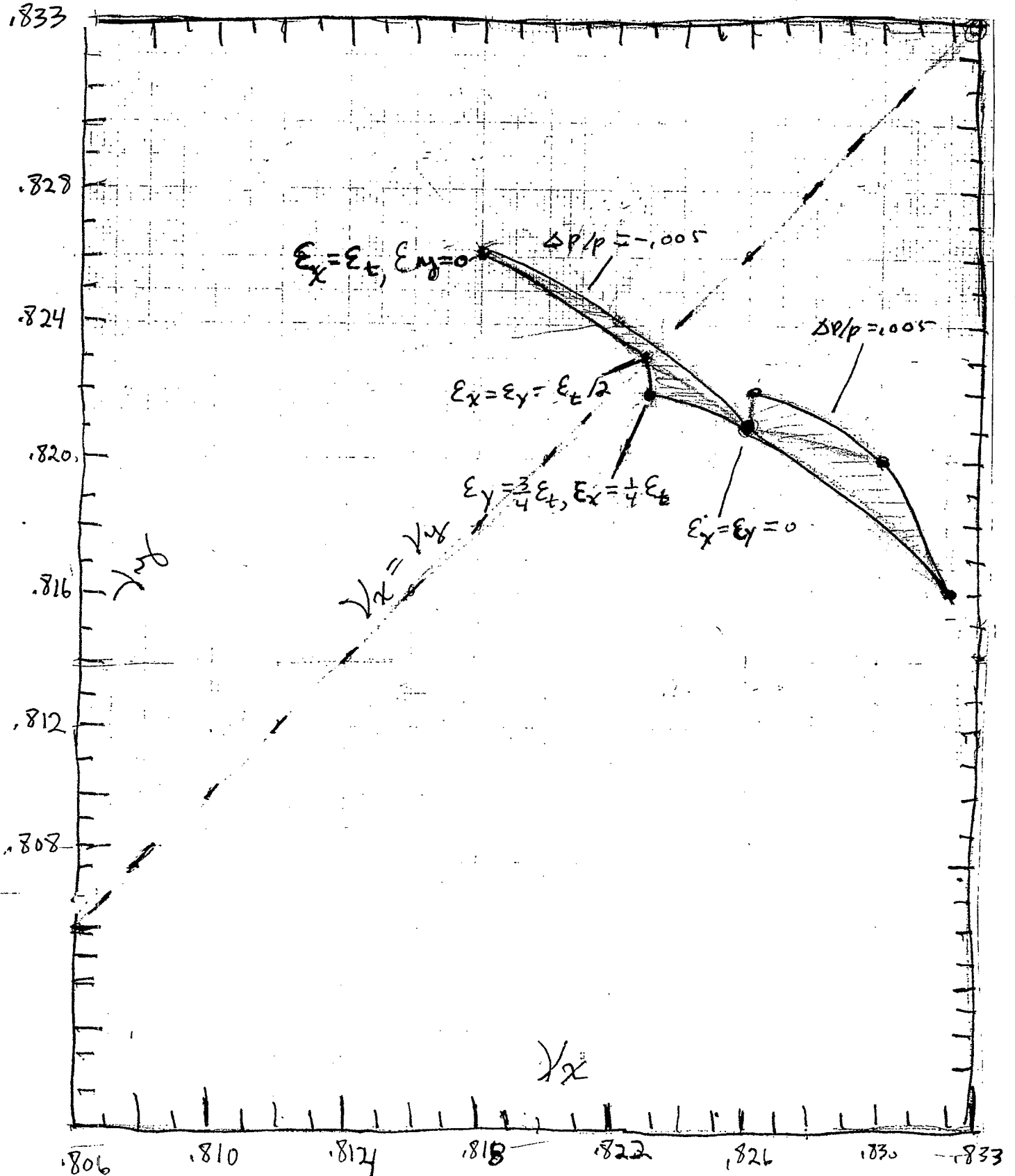$$\Delta V_x, \Delta V_y = 6, -5 \times 10^{-3} \quad \Delta P/p = .005$$

$$\text{Total} \quad V\text{-spread} = 14 \times 10^{-3}$$

(note $b_4' = .75$ here)

γ-spread in 95% of Beam
due to bk, SYS

$\mathcal{E}_x = \mathcal{E}_t, \ \mathcal{E}_{My} = 0$

$\Delta p/p = -.005$

$\Delta p/p = .005$

$\mathcal{E}_x = \mathcal{E}_y = \mathcal{E}_t /2$

$\mathcal{E}_y = \frac{3}{4}\mathcal{E}_t, \ \mathcal{E}_x = \frac{1}{4}\mathcal{E}_t$

$\mathcal{E}_x = \mathcal{E}_y = 0$

$\gamma_x = \gamma_y$

γ_y

γ_x

.833

.828

.824

.820

.816

.812

.808

.806   .810   .814   .818   .822   .826   .830   .833

Multipole Breakdown of D-Spread

		$\Delta p/p = -.005$		$\Delta p/p = .005$				
		$\Delta \nu_x, \Delta \nu_y / 10^{-3}$		$\Delta \nu_x, \Delta \nu_y / 10^{-3}$				$\gamma = 30$
								$x_o = 9.8\ mm$
b_2, only		0, 0						$Y_o = 0$
b_4 "		$-6, 5$		5, -4				$\mathcal{E}_t = 1.92$
b_6 "		$-1, 1$						
b_8 "		0, 0						
b_{10} "		0, 0						
b_{12} "		0, 0						
b_{14} "		0, 0						
b_{16} "		0, 0						
b_{18} "		0, 0						
	Total	$-7, 5$						

Tolerance on b_4' to give $\Delta\nu_{spread} = 3\times 10^{-3}$

$$b_4' = .23 \times 10^{-4}$$

at $\gamma = 30$, for $\mathcal{E}_t = 1.92$, $\Delta p/p = \pm .005$

Assuming b_4 Correction gives a factor 2 improvement the tolerance becomes

$$b_4' = .46 \times 10^{-4}$$